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"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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CONTENTS

THE PROTECTION OF POND EMBANKMENTS AGAINST WAVE ACTION.

By H. L. Canfield,
Supt. of Fish Culture, U. S. Biological Station, Fairport, Iowa.

Much difficulty has been experienced in maintaining pond embankments against wave action and many crude as well as pretentious devices have been resorted to in an attempt to satisfactorily cope with this problem.

Of the methods available, rip-rapping is known to be effective and is used in certain cases, but the expense involved is prohibitive for general use and this construction provides a harbor for crayfishes and various other fish enemies and is not favorable to the production of food for fishes, therefore, it is regarded as generally unfavorable by fish culturists. Willows will hold the embankments, as will some of the rushes, but these cannot be controlled, and are not considered satisfactory for general use about ponds, although they are of benefit as a protection against wave action under certain restricted conditions.

The demand for a satisfactory method of combatting destructive wave action, especially in connection with fish cultural operations, has been indeed pressing.

It is unnecessary to quote figures on the upkeep of pond embankments to emphasize the importance of the subject, but as an example of the extent to which persons have expended money and labor in an attempt to meet this problem, the experience of Mr. W. T. Marr, of Ainsworth, Iowa, will be given. Mr. Marr has a farm fish pond of about 1 acre in area and the wave action on the embankment at the outlet of the pond (which is about one-fifth of the circumference) gave so much trouble and required so much labor in repairing, that he decided to build a cement abutment to meet the situation, which he did at a cost of $100.00. This was about five years ago. When winter came on, however, the ice cracked the abutment in several places and it settled into the pond, so two years ago Mr. Marr placed a heavy fence of two-inch planks just over the cement abutment which, he estimated, cost him an additional $100.00, making in all $200.00 expended in

an attempt to provide a satisfactory embankment protection, not counting the cost of upkeep in the meantime. He now states that he has to frequently fill in back of the fence with dirt to replace that washed out between the abutment and the planks. Thus, after the outlay of much labor and expense, he is anxious to procure a satisfactory preventive against destructive wave action and intends visiting the station at Fairport, Iowa, to learn our method first-hand, with a view to using it on the embankment of his pond.

The problem of prevention of wave action against pond embankments in relation to fish culture is primarily to provide something that will bind the soil; serve as a breaker against wave action; be easily controlled; inexpensive to introduce, and generally favorable to fish life. All of these requirements are met and additional benefits to be had by establishing at the water line of pond embankments a sedge, common in middle west lowlands, where it is known as wire-grass, sour-grass, etc., the scientific name of which is *Carex stricta*.

Carex stricta is a tough, fibrous sedge with numerous lengthy fibrous roots and stolons which grow in abundance and serve to securely tie embankments. It grows to a height of four and one-half to five feet and continues through the summer until late in the fall. By reason of its tough, fibrous texture and abundant growth, a protective "mat" is then formed, which is effective against wave action throughout the winter and early spring. The sedge does not "winter kill," whether the ponds are filled or empty, and the young shoots break through the ground early in the spring. It has a tendency to grow up the embankment rather than around the pond, and only penetrates into the water in very shallow places. There are over 1000 sedges of various types, several of which are useful for protection of pond embankments, but *Carex stricta* is found to be especially desirable for the purpose. To emphasize the tough fibrous nature of this sedge, it may be mentioned that this variety and several other sedges are consumed in large quantities in the manufacture of the so-called "Crex," or grass, rugs, and also in the manufacture of binder twine.

Carex stricta has been successfully used as a preventive of wave action against fish pond embankments for the past six years under trying conditions and this test, coupled with a series of experiments

Fig. 1. Pond No. 3, Series D.

Stake to right indicates original edge of embankment; center of cardboard, base-sod line; left end of cardboard, where washing was checked. The waves had cut into this bank six feet, but was stopped immediately by *Carex stricta* sod.

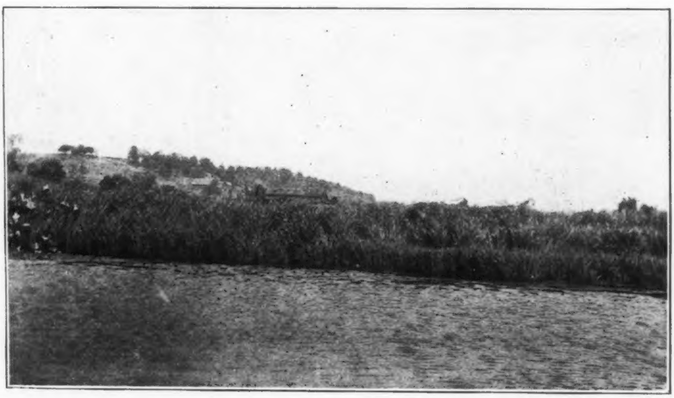


Fig. 2. Trimmed and Untrimmed Sedge.

This sedge joins that shown in photo above.

(Photos by J. B. Southall.)

FIG. 3. *Carex stricta* Sod.
Left, stolon ready for planting; right, result after one year.

(Photo by J. B. Southall.)

at the U. S. Fisheries Biological Station, Fairport, Iowa, in growing and transplanting, justifies its recommendation as an efficient and satisfactory preventive of wave action against pond embankments and especially so in connection with fish cultural operations. The sedge furnishes shade and a place of refuge for fishes. Insects are attracted to the ponds by it, and its submerged parts provide a harbor and breeding place for aquatic life, all of which stimulates the production of fish food, adding to its value as a binder for fish pond embankments.

Attention is called to photograph No. 1, which was taken of Pond No. 3, Series D, for the purpose of showing the *Carex* sedge in use. This embankment was cut down for a distance of six feet by wave action and was being steadily washed away until suddenly and permanently checked by the planting of *Carex stricta* sod. The stake to the right indicates the inner edge of the original embankment. The clearing presents a view which shows the line of the *Carex* sod as originally laid; the general appearance of the sedge growing about the pond and the distance it has grown up the embankment and into the water since the time of the original planting which was four years ago. Since the day of the introduction no perceptible washing of the embankment has occurred.

Photograph No. 2 shows the *Carex* from the water to the top of the embankment. The water line and embankment may be beautified if desired by trimming the *Carex*. Photograph No. 3 shows a stolon (left) ready for planting; at the right the result after approximately one year's growth.

METHODS OF INTRODUCTION.

The sedge has been grown from seed at the Fairport Biological Station, but this method of introduction is not recommended for two reasons. First the expense of collecting the seed is excessive, because the sedge produces only a very limited amount. Second the seed was found to thrive in moist soil, but failed in wet and dry soil, consequently, the waves washed out the seed before it established itself in any but protected places. The quickest and therefore the most efficient manner of introducing this sedge is to transplant the sod from the wild state to the pond, laying it in a line around the pond on the base formed by waves, care being

taken not to allow the tops of the sedge to be submerged. A safe rule is to lay the sod so the top of the dirt is a little above the water surface and maintain this level for about a month or until the sedge becomes attached.

Where the sedge is not available close at hand the stolons may be collected or purchased and shipped to any point desired. By gathering the stolons and transplanting them to the inside border of the base formed by wave action, care being taken not to allow the tops to be submerged, a very satisfactory growth may be obtained the first year. The result will, however, be proportionate to the care with which the stolons are planted and given opportunity to take root. The tops should not be allowed to hang in the water or the water to be quickly raised, thus disturbing the plants before they become established, as the sedge must have air above the water and will be killed out by submerging. By planting the shoots 3 inches apart a good stand should be obtained the first season and 6 inches apart gives a satisfactory stand, while one foot apart is the maximum distance that should be attempted. The stolons should be obtained for planting during May and June to allow as long a growing period as possible the first season. Any man familiar with setting out plants can do the work.

When the sedge is being introduced it is recommended that one entire pond border subjected to the greatest wave action be planted, the plantings being made reasonably close together to provide necessary protection as quickly as possible. As stated, the transplanting of sod is best because immediate results are obtained, but the planting of stolons is cheaper and when carefully done is very satisfactory.

When a new pond is completed and the water is turned into it, as it overflows, the wave action indicates the water line immediately by cutting a level base into the embankment around the pond. The prevailing direction of the wind determines the particular point of excessive wave action and if the wind is high much damage is done. Therefore, immediate protection must be provided new embankments until permanent methods are installed and a hastily constructed "boom" will meet the emergency effectively. This can be made of 2 x 4's, boards, timbers, old cross-ties or other available buoyant material, by attaching them end to end at a distance of a few inches apart by means of staples

and wire or rope. The "boom" should then be anchored from both ends near the sides of the pond at sufficient distance to maintain it two or three feet clear of the embankment receiving the wave action. Such a "boom" is also of value for use at rough points to protect newly introduced stolons until they take root.

SUMMARY.

1. *Carex stricta* is an efficient protection against wave action on pond embankments and is especially desirable in connection with fish cultural operations.
2. It binds and secures pond embankments by means of its abundant root system against seepage, heavy rains, etc.
3. It provides food for fishes above and below water.
4. It provides an avenue of escape for young fishes from their common enemies.
5. It is easily and cheaply introduced.
6. It provides shade for fishes.
7. It is a rapid grower and is easily controlled.
8. It beautifies pond embankments.

HATCHING FRY IN GRAVEL.

By A. Robertson,
Harrison Hot Springs, British Columbia.

INTRODUCTION.

In 1915 I was induced by the general decline in the salmon canning industry and more especially by the scarcity of sockeye salmon on the spawning grounds, and also by the doubtful success of the present hatchery system, to make some investigations and comparisons between it and the natural mode of incubation.

Very little investigation sufficed to show that naturally hatched fry were much superior in size and capability to the hatchery product, and also that this superiority was attained in less time, due to the prevalence of warmer water in the natural beds than that used in the hatcheries. This superiority was apparent even in the eggs; eggs dug up out of the gravel presented a florid and swarthy appearance, which was lacking in our hatchery eggs, and this indicated the presence of stronger embryos. When the fry had absorbed the sac the difference was still more pronounced, and particularly noticeable in the length of the gravel hatched fry which were approximately twenty-five per cent longer and fifty per cent heavier, and also in the size of the eye, which was from one hundred to two hundred per cent larger.

In strength and capability the difference was as between day and night; the wild natural fry hugged the shore singly or in very small schools, and when pursued made for a hiding place with frenzied erratic dashes. Hatchery fry when liberated swam aimlessly about, and only after repeated onslaughts of trout and ducks, during which they lost heavily, were they herded into shallow water and comparative safety. This condition of affairs is only to be expected, for the smooth sides and bottoms of hatchery troughs offer no inducement to the fry to seek hiding places, and their instinct in this respect is soon dulled. On the other hand, fry that have come from the gravel and darkness are movement and light shy in the highest degree.

Having demonstrated, to my own satisfaction, that there was room for great improvement, I have since then experimented in various ways to ascertain the good features of both methods, with the view of combining them.

Nature is prodigal and only the fittest survive, and this fitness is the only redeeming feature of natural incubation. The production of a greater number of fry from a given number of eggs, and the greater protection afforded these fry up to the time of liberation, are the strong points in favor of the hatcheries.

While it cannot be denied that the eggs, as laid by the female fish over an extended period of time, are more susceptible to virile impregnation, which never can be equalled by human agency, still it is doubtful whether the present methods of taking the eggs from the fish, when ninety-five per cent or over are fertilized, will ever be improved on and need not be discussed here. From this stage on, however, the divergence in procedure has great effect and the object of this paper is to point out the shortcomings and merits of both systems as they appear to me.

WATER CIRCULATION IN THE GRAVEL.

Spawning salmon seek out beds where seepage occurs and ignore seemingly suitable spots where this condition is lacking, and experiments in connection with this prove that eggs will not survive under the water without circulation.

I made four tubes of basket wire twelve inches long and one inch in diameter, filled them with eyed eggs, and buried them under one foot of water and one foot of gravel, with water running over them. After a lapse of four days I dug one up and found the eggs in an advanced state of suffocation, which, though not enough to kill, was sufficient to seriously impair the strength of the resulting fry. Each succeeding day I dug up another with increasing bad results, and that on the seventh day was ninety per cent dead. A tube of eggs, buried similarly, fifty feet away where the fish did spawn, hatched successfully. I also filled several glass jars six inches high with eggs, placing same under running water in a trough, and found that they died from the bottom up at the rate of approximately an inch per day, and eggs buried in gravel in a dish one inch deep, placed similarly, died in a week. This may

correct an impression that every gravel bar is a spawning bed and accounts for the partiality shown by fish for certain localities.

Seepage is not subject to the fluctuations in volume and temperature prevailing in surface water and is cleaner and more free from debris.

WATER CIRCULATION IN THE TROUGHS.

The circulation in hatchery troughs is indirect and is not conducive to the production of strong fry. The eggs are in a mass in the basket, which varies from one to two inches deep, and the water, following the path of least resistance, passes to a great extent under, over and by the sides of this mass. Even when fifteen to twenty gallons of water per minute and riffle dams are used, the eggs in the centre of a two inch mass are in a state of semi-suffocation, and killing is only prevented by shaking up. Eggs having all the appearances of suffocation may recover if thinned out or shaken up, but the effect of this semi-suffocation must be cumulative and must affect the strength of the resulting fry.

I spawned a number of eggs and placed a layer two inches deep in a hatchery basket subject to the normal water supply and riffle dams, and from the remainder I filled a whitefish jar full. Just before the eggs hatched I counted the number of eggs to the lineal metre several times from both basket and jar, and found that the jar eggs were at least five per cent greater in diameter. In the jar the circulation of water was direct; in the basket indirect; and while this test may not be conclusive, a straw shows how the wind blows and I intend going into it thoroughly this winter.

TEMPERATURE OF WATER IN THE GRAVEL.

Seepage, according to the distance it has traversed the earth, varies in temperature, ranging up to the temperature of so-called spring water, which is about forty-five degrees, and varies very little throughout the year. The temperature of water in the streams from which the hatchery supply is taken very often descends to thirty-four, and it is therefore quite obvious that the natural incubating period may be half that of the hatcheries. Some authorities are opposed to the use of spring water because

it hastens the incubating period and compels the liberation of fry in the late winter when food is at its minimum, but it is reasonable to presume that in springy localities the same temperature that hastens egg incubation also hastens all other forms of aquatic life and food is thus automatically provided.

In any event water of warmer winter temperature than that used in the hatcheries is the natural element, and the aversion to its use is based on the presumption that the temperature of the running water in a stream determines the length of the incubating period of the eggs that are deposited in it. This is not so, however, for temperature readings taken from beneath the bottom of streams, and from holes dug in the banks and bars, gave temperatures as much as eight degrees higher than that of the running water above, and I am also partially convinced that the time of emergence of the fry is not dictated by the absorption of the sac alone and may depend on the temperature of this blanket of cold water above them.

Another point in this connection I wish to emphasize is, the sequence of the time of spawning of the different kinds of Pacific salmon is: sockeye, humpback, spring, dog and cohoe. This sequence also obtains in a general way in the comparative strength of fry of these fish. Heretofore sockeye eggs, when procurable, were the only salmon eggs handled in British Columbia hatcheries, where their development was retarded in surface water of low winter temperature, while their aggressive and less worthy cousins, hatched naturally in spring water, had advanced in growth sufficiently to be able to devour the sockeye fry when they were liberated.

The moral is that in the absence of good reasons against it, the liberation of the fry of any species should synchronize with that of the same species in nature.

DEPOSITING THE EGGS NATURALLY.

In depositing the eggs the action of the fish's tail scoops a hollow in the gravel, and the eggs when expressed, are carried by the current into the interstices. The eggs are not deposited in masses, and as the fish works forward they are covered. This takes place while the eggs are in the soft state, and as they harden and swell they assume the shape of the interstice in which they

happen to lodge. When they have hardened all movement is presumed to have ceased and they remain immovable and in darkness till the fry hatch.

This is only theoretically so, however, for in nature especially the best laid plans often come to grief. Very likely before the eggs have hardened another pair of fish dig them up in the act of depositing their own, and overseeding, the principal destroying factor in natural propagation and the automatic governor of reproduction prior to the advent of the white man and intensive fishing, still has some effect in certain localities.

I know of humpback spawning beds that are sometimes spawned over ten times, and in many cases the eggs of finer and early running varieties, such as sockeye, are dug up by dogs and cohoes. Washouts in the streams and receding water, leaving the eggs dry, are also foes to natural spawning, and many eggs are devoured by trout, etc., before they are covered.

Judging from the necessity of egg picking in the hatcheries and the bad effects resulting from fungus if it is neglected, one would suppose that the loss due to fungus in the gravel would be enormous. From experiments and observations I am convinced that the loss from this cause is negligible because the eggs are not deposited in masses, and also because the infertile egg, the source of nearly all the trouble in hatcheries, if not disturbed and kept in darkness, has an existence that covers the incubating period. This life may be described as merely a state of existence without growth. Very little abuse will extinguish this existence, and sudden changes in temperature are also fatal, and it is considered good hatchery practise to abuse the eggs until they are eliminated.

I contend that the removal of the infertile egg, and in fact picking of any kind, is wholly unnecessary, and that the presence of dead eggs of any kind should be viewed as a sign that there is something wrong with a system that produces them.

I first noticed this phenomenon in 1916 amongst some dog salmon eggs I had buried in gravel, when I dug into it to see what was happening, and in 1917 it was quite evident in many whitefish jars. On December 5th, 1917, I filled a whitefish jar with infertile eggs and gravel and on the 5th of April, 1918, these infertile eggs had not decomposed and were in as fresh a state

as when buried four months before, while eggs spawned the same day and fertilized, had hatched. I put this lesson into practise at Cultus Lake Sub-Hatchery, which is under my charge, in 1916 and 1917. The troughs there are within two hundred feet of the fish traps and consequently it is an easy matter to place the eggs in the baskets before they harden. When this was done no picking was necessary, and the eggs were not disturbed until they were well eyed and then only because the accumulation of silt, etc., compelled shaking up, which, of course, ended the existence of the infertile eggs. I did the same thing with humpback eggs at Harrison Lake; put them in the baskets soft, never disturbed them till well eyed, and then separated them in brine.

DEPOSITING THE EGGS IN HATCHERIES.

In any instructions I ever read regarding the handling of eggs, no mention is made of the desirability of getting the eggs into the baskets before they harden. On the contrary the method usually advocated is to allow them to harden before they are put into the trays in which they are to be transported, and some hatcherymen even allow them to harden in the milt.

If the eggs are taken at a distance from the hatchery it is impossible to follow the method I advocate, and the best results need not be expected.

At Cultus Lake the spawning pans, holding five quarts, were filled, carried to the troughs and emptied into the baskets, where they were washed. Thus two operations sufficed instead of the customary five, namely, spawning pan, washing pan, measure, tray and basket, and in addition no first picking was necessary.

The transportation of eggs, especially those not eyed, is inimical to the production of strong fry, for though it may not actually kill, it has a weakening effect.

GRAVEL HATCHED FRY.

Assuming that the fry have hatched successfully in the gravel, in spite of the drawbacks enumerated, we find that the fry stay in the gravel until the sac is absorbed, and longer under certain conditions which at present are unknown.

It may depend on the food supply, on season, or on the temperature of the water, but I am convinced that the time of

emergence is not dictated entirely by the absorption of the sac. When I emptied the gravel out of some boxes last spring I found a few very large fry, fifty per cent longer and two hundred per cent heavier than any I had previously seen come from the gravel. I showed specimens of these fry along with others taken from the natural beds and from the troughs to Mr. Cunningham, Mr. Babcock, Mr. O'Malley and Dr. Gilbert and they were all astonished at the contrast.

I am convinced that the contents of the sac was not alone responsible for this fine growth and the only feasible explanation I can think of is that they fed on the dead eggs or on the other fry, and this hypothesis is not unreasonable when we know they will eat the bodies of their parents. I also contend that the large eye, so evident in these fry, is a certain indication of strength and a great aid in eluding their enemies. Fry that hatch head first are weaklings and they have all small heads and eyes. Fry hatched in water of high temperature, sixty degrees or thereabouts are what we call "pinheads," which means that their heads are not developed. Examine the screen at the foot of a trough in which the fry are hatching and you will find a preponderance of small eyed or blind fry amongst the abnormalities.

HATCHERY FRY.

Hatchery fry are born under a handicap due to indirect water circulation, handling, and the bad effects of light, and this follows till they are liberated. They are on the move continually and the contents of the sac is dissipated in energy, which is unnatural. This movement is due to an inclination to get to the head of the trough and fresh water, or to avoid the light, and, to prevent piling up and consequent suffocation, they have either to be riffled or the screens so placed to attract the fry under them.

Provision against light usually consists of a few covers on the troughs or blinds on the windows, and these are inadequate, and the movements of the attendants has such a taming effect that they will actually come to meet them if they are being fed.

As I stated before, the smooth sides and bottoms of the troughs are not conducive to fostering their hiding proclivities and this soon becomes weakened; to counteract this somewhat I placed a layer of fine gravel in the bottom of all the troughs last season, with good results.

HATCHING FRY IN GRAVEL IN CONTAINERS.

Having thus demonstrated to the best of my ability that the predominating features of natural reproduction are the production of strong fry and lack of protection, while the reverse obtains in the hatchery method, I now proceed to show how these defects may be overcome.

In a general way, what I advocate is to take the eggs in the customary way and place them in their soft state in a container where no movement can take place, where they are in complete darkness, and subject to a direct flow of water which is under control and not of a fluctuating surface nature.

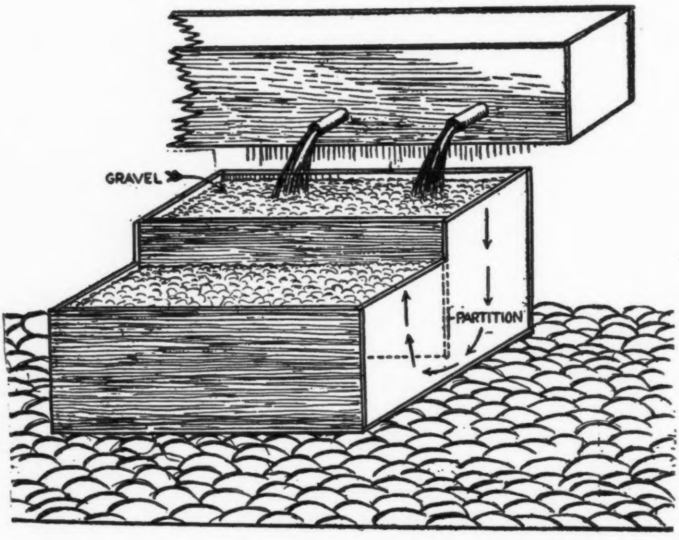
I have been compelled for lack of room in the hatchery to bury eggs in streams and beaches, but several years ago came to the conclusion that it was impracticable and not as good as the fish could do it themselves. Owing to their buoyant nature it is next to impossible to bury eggs under water, and when it was done it did not eliminate any of the faults of natural spawning with perhaps the exception of overseeding.

I then turned my attention to burying in whitefish jars, gasoline cans and boxes, and found after trying ten different forms of containers that the one I built first, a cut of which is appended, was the best of all. In the whitefish jar, where the water is conducted to the bottom through a tube and rises up through the mass of eggs, the principle of direct circulation is clearly illustrated, and all the other containers are merely modifications of this principle.

Gasoline cans, with a tube connected to a distributing board are practically the same thing. The water, however, may just as well be used going down as coming up and the wooden containers embody this feature. The use of whitefish jars is only recommended for experimental purposes as they allow a clear view of what is transpiring, but they are costly, easily broken and no better in operation than boxes made of common one inch lumber and lacquered.

If spring water is used danger from freezing is obviated and the boxes need not be in a building. They should be set up where the overflow spills into a creek or pond, which should purposely be left in its rough state to provide hiding places for the fry, or brush and rock added if cover is lacking.

In filling, the common run of gravel from two inches down is used, the larger rock serving to bear the superimposed weight, while the smaller holds the eggs in place. Much sand in the gravel is not desirable and large or small rock alone is not satisfactory; with one the interstices are too great, while the other works into the consistency of soup. Some of the larger sized gravel should be placed under the partition to provide free passage for the water, and two inches of the mixture on the remainder of the bottom. Some soft eggs, at the rate of one part of eggs to ten of gravel, are then gently and evenly distributed by hand and sprinkled with water to settle them into the crevices, and gravel and eggs added alternately until the box is full to within two inches of the top of the lower side. The remainder of the lower side should be filled with the mixture, and the upper side with fine gravel to within two inches of the top. This fine gravel acts as a filter and excludes debris.



Fry Hatching Container (A. Robertson).

The water at the rate of about one gallon per cubic foot per minute is then turned on, and thereafter no attention other than seeing the water is kept running is necessary. The eggs need not be actually in the water until the filling is completed, but this should be done as expeditiously as possible. To the uninitiated this may appear rough treatment for fragile fish eggs, but they may rest assured that no harm will ensue if the eggs are soft. To attempt it with hardened eggs is disastrous, but eyed eggs may be safely buried, and as an expedient this may be done with eggs eyed in the troughs and then transported and buried in suitable places.

In 1915 I had one container in operation. In 1916 seventy, and in 1917 ninety of ten different types, with a combined capacity of over two million eggs. Fifty of these are at Cultus Lake and were filled with sockeye eggs, all hatched successfully with the exception of two which were later found to have running pitch seams in the wood. This distressed the fry and they emerged with the sac on. The gravel in all these boxes with the exception of the two mentioned was found to be clean and free from dead eggs or fry when they were emptied.

In the course of my duties I visited this station in the day time once a week, and was struck by the fact that no fry were to be seen emerging. I mentioned this to the man in charge and he laughed and said: "If you were here after dark with a lantern you would find the top a squirming mass of fry." This peculiarity was later corroborated at Harrison Lake and indicates that fry planting should be done at night.

If the water in one of these boxes stops running, the fry will attempt to emerge, but if handicapped by too much sac they are unable to do so; on the other hand, if not distressed, they will descend as far into the gravel as they possibly can. I filled a jar half full of gravel and placed a quantity of eggs on top and when they hatched they all went down into the gravel.

I built a trough twelve inches square and twelve feet long, with single riffles two feet apart extending alternately two inches from the top and bottom, and filled it with gravel and eggs its entire length, afterwards nailing a cover on. When the fry ceased coming out I emptied the trough and in it found the large fry mentioned previously, all the others were gone, some of them

traversing ten feet of gravel. Many years ago I saw an instance where fry from a leaky pond travelled two hundred feet through the earth, emerging on a meadow; hence their ability to get out need not be questioned.

When I am asked if the gravel system is as compact as the other I usually suggest to the inquirer that he substitute "congested" for compact, for that is the way I view it. Last year I took out a group of four sixteen inch by sixteen feet troughs and in its place erected a system for sixty gasoline cans. I put one hundred and eighty quarts of humpback eggs in these cans in varying quantities and sizes of gravel for experimental purposes. Some of them were purposely overloaded and one hundred and twenty quarts would have been enough. Now one hundred and twenty quarts would have been a good load for the troughs I took out, but it must not be overlooked that the trough and basket method has only area, while the other has area multiplied by the depth of gravel. Anyway, compactness is no consideration when better results are obtained, and the same thing applies to the quantity of water used, which is twice that of the old way.

Another question I have been asked is, "Is the proportion of fry turned out as great as from the troughs?" Now, while I have never counted the number of fry emerging from a container, I have seen the contents of perhaps fifty whitefish jars hatch and the fry leave in plain view, and when I say that the proportion is as great or greater I know whereof I speak, and I also add that I consider that gravel hatched fry have ten times the chance of survival that trough fry have. One drawback is the difficulty of finding suitable water and the use of gravel is cumbersome and slow, but it is altogether likely that some other burying medium, which must allow for expansion and the passage of water, will be found to take its place.

Its principal recommendations are, low cost of installation and operation, but all the arguments for and against it pale into insignificance in the light of its chief recommendation, which is, **the production of strong wild fry.**

THE RACEWAY AS A FISH TRAP.

By A. Robertson,
Harrison Hot Springs, British Columbia.

In 1914, after the great disaster to the Fraser River sockeye salmon run of 1913, with the approval of Mr. Cunningham, Chief Inspector of Fisheries for British Columbia, I built a chute in Trout Creek with the object of ascertaining the power of salmon to ascend a stream devoid of natural resting places.

The circumstances of the catastrophe at Hell's Gate are familiar to all interested in the Pacific Coast fisheries, but, for the benefit of others, I would explain that it was caused by the dumping of great quantities of railroad building debris into a naturally restricted part of the Fraser River. Some time after the railroad was built, the situation was aggravated by the fall of a rocky cliff, the base of which had become weakened by the cutting of the road-bed. The north bank of the river at this point consists of a vertical and comparatively straight rocky wall, while the south bank where the trouble occurred was irregular.

The result of the dumping of so much rock was that these irregularities were filled up and a chute was formed in the river. Above and below Hell's Gate minor stoppages were caused in the same way, and these, for the purposes of this paper, are more important than the great blockade at the Gate as they show that very little interference with the course of a stream may result in great injury to the fish, and probably that considerable spawning areas are barred through minor obstructions.

For the benefit fo the lay reader it should also be explained that the ascent of salmon consists of a succession of diagonal rushes from side to side of the river or past obstructing projections. When the fish find themselves stalled in their ascent they instinctively cross the stream; they are incapable of sustained effort and must find resting places at short intervals.

The chute built in Trout Creek is one hundred feet long, nine feet wide and four feet deep, with an even grade of five per cent, and the velocity of the water, which varies according to height, is about ten feet per second. Many hundred attempts to ascend

this chute have been made by salmon, chiefly cohoe, but no fish ever succeeded in reaching the fifty foot mark, while ninety per cent failed under thirty-five feet. The behavior of the fish was the same in most cases; when they found themselves stalled they instinctively crossed to the opposite side trusting to find an eddy. The results of this experiment show that salmon are not nearly as capable as generally supposed, and incidentally the chute served another purpose of more immediate interest to hatcherymen. It proved that it could take the place of a fence or rack to stop fish for spawning purposes.

All hatcherymen who have attempted to keep a fence clean during a freshet in the fall when the leaves are falling will appreciate a contrivance that stops the fish, does not require cleaning, and with the added advantage that the higher the water rises the better it fishes. Of course it only serves to stop the fish, but if part of the water is diverted down the outside of the chute through a head-gate, or the chute built just above a small tributary it will be found that the fish after a few ineffectual attempts to rush the chute will compromise by taking the side channel.

The second season after building, a fence was constructed at the lower end of the chute and a pond formed in it by placing a two by twelve across the bottom. The fish leaped the plank, entered the fence through the lead provided, but could not get out of the upper end. Paradoxical though it may appear the chute formed a pen though open at one end.

Chutes could also be used to prevent the migration of inferior fish, and a little experimenting would determine the length necessary to stop these fish while allowing the others to pass. It would thus act as an automatic separator.

THE PARENT FISH AS A FOOD SUPPLY.

By A. Robertson,
Harrison Hot Springs, British Columbia.

In 1915 I buried seventeen hundred stripped sockeye salmon in the garden at Harrison Lake for fertilizer. In the spring I was astonished to find that many of these fish were intact and in

a fair state of preservation. I threw several into the ponds through which the fry are liberated and was surprised to see the fry attack them with such relish that in the course of a few days nothing but the skeleton was left.

Sockeyes in particular seemed very partial to them, and it was a fine sight to see several hundred fry tearing into one carcass, with as many more waiting down stream to catch the fragments.

It was the first and only food I had ever seen sockeye fry care for and thrive on, and on account of it they stayed much longer in the ponds than usual.

The following fall I buried a lot more fish in various ways to find out the best method of preservation, but either because they were fly-blown before burying or because frozen during the winter, none of them were in the same condition in the spring as those of the previous year.

However, two hundred dog salmon that I had thrown into the ponds in November came through the winter in good condition and met with the same fate as the sockeye of the year before.

Now, while the mode of preservation is still in doubt, the results are most decidedly not so. I have learned that the bodies of the fish must not be fly-blown before burying or frozen during the winter, and if kept in the water it must be running and under forty-five degrees temperature.

There is no doubt that they are a natural food for fry, for in the spawning streams the bodies of the parent fish lodge in log jams and amongst the rocks and stay there till spring. Then when the rising temperature of the water tends to decay, and freshets disintegrate the flesh, the particles are snapped up by the fry.

I am quite convinced that a little experimenting will lead to a sure way of taking advantage of this provision of nature; they have accidentally been kept over winter in two different ways and it can be done indefinitely. In connection with this I would cite the testimony of a very old Indian who declared that the hatchery fry were "no good because they had no mamma." He said that after the fish had spawned they died above the eggs and when the "papoose" came out in the spring they were assured of an immediate food supply.

WHITE PERCH NOTES AND METHOD OF PROPAGATION.

By Fred J. Foster,
U. S. Bureau of Fisheries, Neosha, Mo.

For many years large numbers of white perch (*Morone americana*) have been noted above and below the Dobsis Lake dam, in Washington County, Maine, during limited periods in the months of May and June. The following observations were made during the spring of 1918 in an experimental attempt to retain these fish for brood purposes and to collect eggs for propagation. Unlike the white perch of coastal waters, those of Dobsis and Compass Lakes remain throughout the year in fresh water and therefore the peculiarities of movements and conditions may or may not apply to fish of salt or brackish water.

The spawning season in this locality extends for at least two months, approximately the months of June and July, perhaps not more than 10% of the fish being ripe at the height of the season, with decreasing percentage toward the beginning and end. The first eggs were secured on May 27th. Operations were closed on June 20th, but on July 22nd the writer, with hook and line, took 22 white perch in Dobsis Lake, among which were 3 gravid females and a number of males still in spawning condition.

The first run of fish into the stream connecting Dobsis and Compass Lakes, during 1918, occurred on May 19th, and the run continued, in fluctuating numbers, throughout the period of observations. During the first three days, before the installation of the trap, an estimated number of 1500 perch had ascended the stream and settled below the dam. These remained about a week and then drifted down over the barrier net, which had sagged below the surface of the water in the swift current, and back into Compass Lake.

On June 3rd some 2800 fish were liberated between the barrier net and dam, for reasons which will be given later, permission having been received from parties controlling the dam to lower one of the gates sufficiently to prevent the barrier net from being submerged. On June 10th, one week later, it was considered advisable to change the location of this barrier net and during the

operation the fish, which as a rule lie in a deep pool some 50 yards above, suddenly took the notion of returning to Compass Lake, as had the former school.

A few days later a number of fish descended into the stream from Dobsis Lake, remained less than 24 hours and departed. A large school was noted along the shore of Dobsis Lake, some two miles from the dam. These remained in a limited area for some time, but were gone when we returned with nets.

The schools entering Dobsis Stream from both Dobsis and Compass Lakes, as well as fish secured from along the shores of the Lakes, showed all degrees of ripeness, from fish so green that it was impossible to determine the sex, to ripe fish. The foregoing would indicate that, unlike most fish of fresh water, the white perch has no preference as to spawning place or conditions; individuals in the school depositing their eggs wherever the school may happen to be. In fact, it was determined by opening a number of females at various times, that the eggs mature a few at a time over a period variously estimated at from 10 days to 3 weeks. Females would be stripped of a goodly quantity of fine ripe eggs and when opened would show at least one-third of the eggs which had not as yet separated from the ovaries. It is therefore reasonable to suppose, considering the movements of the schools, that a given individual may deposit its eggs at points miles distant.

Both web enclosures and wooden crates were used for retaining pounds and many experiments were made as to the number it would be possible to hold to a given space, and the proper flow of water through the pounds. All endeavors to empound these fish, however, resulted in failure. It was further found that the eggs secured from fish held for not more than 24 hours were of good quality; fish held from 24 to 48 hours produced eggs of only fair quality; from 48 to 72 hours, the eggs secured were practically worthless, and fish that were too green to ripen within that time failed to mature, the eggs hardened in the abdomen and the fish rapidly became blotched with fungus. Extreme care in handling and the most favorable empounding conditions failed to improve the results obtained. The males appeared slightly more hardy than females; after a few days, however, the milt would congeal and be valueless for fertilization. Just previous to the close of operations it was learned that experiments conducted by the

Massachusetts Department of Fish and Game, in holding white perch in both fresh and brackish water, produced approximately the same results. Holding in salt water is yet to be tried.

The possibility of securing better results by liberating the fish in the stream between the barrier net and dam, where with difficulty they could be seined up and sorted every third day, was the reason for releasing the 2800 fish previously mentioned. During the week prior to their escape no improvement was noted. This, however, was not a fair test of the feasibility of this scheme, as the fish were not in the best of condition when released. Considering the large percentage of green fish and the length of time it would be necessary to hold them, it is problematical if they would stand the necessary handling.

White perch eggs are very small, 50,000 being estimated to the fluid ounce, or 28 to the linear inch after being water-hardened. They are even more adhesive than the eggs of the pike perch and the use of starch to aid in separation seems of no value. Agate or marbleized spawning pans are considered best and a little milt taken first, assists in preventing the eggs from sticking to the pan.

It is well to sort all fish before starting to strip, as better results will be obtained if no delay takes place in manipulating the eggs after taking. The milt from a few males is first stripped into the pan, then eggs and milt taken alternately, the tail of each fish being used to stir the mass after the eggs or milt are taken. This serves the double purpose of thoroughly mixing the eggs and milt and assisting in keeping the eggs separate. After 10 or 12 ounces are taken, the pan is passed to an attendant who, with a feather, continues the mixing for a moment, then a small quantity of water is added and after stirring a minute or two longer the milt is washed off by repeated changes of water. After washing, the eggs are lowered into a pail of water. Water-hardening will take some 30 to 40 minutes and, despite constant stirring, some bunches will form and many eggs will stick to the pan or pail and feather. Good fertilization and care during water-hardening will greatly assist in preventing bunches of fungused eggs from forming while the eggs are in the jars.

The ribs of the white perch are so heavy and arched and the abdominal cavity so short that it is difficult to strip all the ripe

eggs from a female. Ripe eggs not secured will be naturally deposited in the pounds during the ensuing night. A number of females, weighing about a pound each, had every appearance of being spent but upon being opened were found to contain immature eggs and probably would not have spawned for at least a month. Their resemblance to spent fish was so marked as to deceive experienced fish culturists.

If the eggs cannot immediately be transferred to the hatchery after water-hardening, they should receive a change of water at least once an hour and the temperature kept as even as possible.

White perch eggs may be hatched in either open or closed top jars, the Downing jar being preferable. When the eggs are received from the field, they are passed through a bobbinet screen and from 12 to 15 ounces measured to each jar. The eggs do not circulate as satisfactorily as those of the shad or pike perch. The flow of water is adjusted to give as good a boiling motion as possible without flowing the eggs out of the jar.

The eggs are somewhat heavier after being held for a day in the jars and after eyeing will require a greater flow of water than when first measured up. It was formerly customary to replace open-top with closed-top jars after the first 12 hours, but an increased flow of water through the open top jar is equally as satisfactory.

It is impossible to separate the good and bad eggs while they are in the jar so that siphoning is impracticable. The eggs are extremely susceptible to fungus and, unless of exceptionally good quality, it is advisable to remove the fungused bunches, by screening through bobbinet, at least twice during incubation. The bunches from the first screening are thrown away, but from the second, which is usually done after the eggs are eyed, they are placed in "hospital" jars and will produce many fish. Should the eggs in these jars stick together in a mass and stop circulating, it will be necessary to close down the jar and stir the egg mass with a feather every half hour, until hatching is completed.

Eggs of good quality taken from fish held but a few hours in nets or pens, and properly fertilized and cared for in the field, will give little trouble and hatch fully 95%, while inferior eggs are a source of much annoyance and no amount of care during hatching will produce satisfactory results. There is practically no difference

in the appearance of eggs of good and poor quality, and only after working some time in the jars will the difference be apparent.

With a water temperature of 45 degrees, the eggs will show little development and remain nearly dormant. At a temperature of 58 degrees they will hatch in from 4 to 4½ days, while at 68 degrees hatching will take place in about 30 hours.

As the fry are so very small, nothing but good quality nainsook or silk is suitable for screening the collecting tanks. It is advisable to ship all fish from each tank at least every other day, if possible, so that all cast off shells may be removed and the tank and screen thoroughly cleaned to prevent overflowing.

From various experiments it has been determined that both green and eyed eggs may best be shipped in the ordinary 10 gallon transportation can. Four quarts of eggs may safely be placed in each can, and if the trip be one of but two or three hours, and the air temperature moderate, no messenger will be needed. For longer shipments, however, an attendant will be necessary to aerate the water and regulate the temperature.

It is not advisable to pour the water directly from the dipper into the can, as in aerating the water for fingerling fish. It should be transferred to a pail by means of a screened siphon, thoroughly aerated in the pail and gently returned to the can. The water in the can is then given sufficient motion, by means of the dipper or hand, to lift the eggs from the bottom and cause them to separate freely in the re-aerated water.

Placing ice in the can to reduce the temperature is also to be avoided. Cooling should be accomplished by placing a small quantity of ice in the pail while aerating or placing ice on the shoulder of the can or in the can cover, if the covers are adapted for holding ice. A sudden drop in water temperature, if more than 4 or 5 degrees, is injurious, and it is preferable to have a few degrees rise in temperature than to lower it during transportation.

Two lots of eggs were packed in smelt cases, under the same general plan as is used in packing trout and pike perch eggs, and appeared normal when removed from the case, after a period of 3 days, but after working for a day or two in the jars, both lots turned bad and not a single egg hatched. It is believed

that white perch eggs will not stand the drop in temperature necessary to this method of packing.

Efforts were also made to hold small lots of eggs for 24 hours, in a vacuum bottle, but the eggs were dead when removed from the bottle, presumably from lack of aeration.

Owing to their cannibalistic tendency it is well to distribute the fry shortly after hatching. A convenient and accurate method of securing the proper number to the can is to take down the jars just as they commence to hatch and measure the required number of ounces of eggs to the can. By gently stirring every half hour, equally good results will be obtained as if the eggs were permitted to hatch in the jars. By giving the water in the cans a swirling motion all shells and dead eggs will collect in a little bunch on the bottom of the can where they may readily be removed with a siphon.

The usual number carried to a 10 gallon can is 200,000. For trips of more than 10 hours' duration, however, 100,000 to the can will be found to carry better and give the messenger less trouble. The same methods of aeration and temperature regulation should be followed as that described in the transportation of eggs. With 100,000 to the can little if any aeration will be necessary and unless the hatching temperature is above 65, a 5 degree rise in temperature will be found advantageous.

A bright tin or white enamel dipper will show more clearly the almost transparent fry and assist the messenger to convince the applicant that the water in the can contains fish, otherwise, as told by a fish culturist of note, it will be necessary for him to "Plant water and have faith."

INDISCRIMINATE AND INCONSIDERATE PLANTING OF FISH.

By Dr. James Alexander Henshall,
Cincinnati, Ohio.

In the Transactions of The American Fisheries Society for June, 1918, I was much pleased to read a paper by Mr. Aldo Leopold entitled "Mixing Trout in Western Waters." This is a matter to which I gave much thought during my superintendency of the Bozeman, Montana, Station, and I am very glad that the subject has been broached.

Mr. Leopold is evidently a close observer of the streams and their inhabitants in the National Forest Reserve of Arizona, and has apparently given much consideration to the stocking of those streams intelligently. His conclusions are exactly in accordance with my own experience of twenty years in the U. S. Bureau of Fisheries. After observing the results of indiscriminate planting of several alien species of trout in certain streams in Arizona, Mr. Leopold says, in regard to the possible hybridization of the several species:

"1. Species of trout spawning at the same time may hybridize. More knowledge is needed on when and to what extent."

"2. These hybrids are less productive, and therefore less desirable, than pure stock. More knowledge is needed on how much their reproductive capacity is reduced."

The subject of hybridization and all speculation in that direction may well be dismissed, for it rarely, if ever, occurs in nature under ordinary conditions. In compliance with instructions, at the Bozeman station, I experimented with crossing the two closely allied species, rainbow and steelhead trouts, for several years. While the resultant progeny grew to be fishes of good size and fine appearance, they subsequently proved to be infertile.

In respect to stocking waters, Mr. Leopold says that the National Forest Reserve Service in Arizona will hereafter follow nature and stick to one species, and that empty waters will be stocked with the species that seems most suitable; also that stocked waters will not be further mixed, and that native species will always be preferred.

These conclusions are sane, sound and sensible, and agree with those of all practical fish culturists who have given the matter earnest thought and consideration.

As a general thing the streams of the eastern slope of Montana, Colorado and Nevada are comparatively pure and uncontaminated, except in the immediate vicinity of mining camps. There was always an abundance of fishes native to the streams, and their natural food was likewise abundant. Cut-throat trout, Rocky Mountain whitefish, and in certain streams, grayling, lived harmoniously, were well nourished and reproduced their kind year after year, a natural balance of species being maintained.

If these conditions had not been disturbed by the introduction of alien species, and depleted waters had been stocked with native fishes, this happy and natural condition of affairs might have continued for many years to come.

As a case in point I will instance a stream that was under my daily observation for many years. Bridger Creek, a fine mountain stream, flows within a hundred feet of the Bozeman hatchery. When I began operations there in 1896 the Creek was well stocked in about equal numbers with cut-throat trout, grayling and Rocky Mountain whitefish, and this relative condition had always existed. At the end of thirteen years, 1909, when I left the station for Tupelo, Mississippi, the waters of Bridger Creek contained neither grayling nor whitefish, and but very few cut-throat trout. This change was brought about through the accidental stocking of the creek with brook and rainbow trouts from the waste water of the hatchery and ponds. These aggressive species were in entire possession of the stream, the brook trout being in the majority, though neither species was as abundant as the natives were formerly. As the spawning season of the brook and rainbow trouts are at different times, spring and fall, this balance will probably be maintained through the depredations on the eggs, fry and fingerlings of each other.

At that time all the streams of eastern Montana were well stocked with native fishes, mostly cut-throat trout and whitefish, while the grayling existed with them in the tributaries of the Missouri River above the Great Falls. Subsequently indiscriminate stocking of these waters was made with alien species of

trout, for which there was no good reason or valid excuse, except that applicants asked for brook, rainbow or steelhead trout, and they were supplied. If the re-stocking had been done with the native fishes inhabiting each stream, its condition would be much better today. The cut-throat trout is a more desirable species for those waters than the brook trout, being gamer, growing larger, and is a better food fish. Fortunately these waters are too cold for the brown trout.

Even black bass, both species, were supplied to applicants for waters too cold for their existence, some within a few miles of Yellowstone National Park. I protested so strongly against this indiscriminate stocking that eventually all black bass applications were referred to me. The warmer water of lakes on the western slope of Montana are very suitable for the large-mouth black bass, and they have been stocked with great success.

When in charge of the black bass station at Tupelo, Mississippi, applicants were supplied with rock bass and yellow perch, both species being unsuited to the warm waters of southern Mississippi, and Alabama. In these cases such species as croppie, bream and bluegills should have been supplied. Many applicants hear of certain fishes, and without knowing anything about the proper conditions of environment for them, or their habits, but on the score, perhaps, of novelty, apply for them.

A lamentable instance of inconsiderate stocking with an alien species, and one with which we are too well acquainted, was the introduction of the German carp. At that time the unfortunate results of its introduction to our waters could not very well be seen or anticipated. It was intended, primarily, for the stock ponds of farms, as it was supposed that it would thrive in any kind of water, muddy or stagnant. It was supposed to be herbivorous and harmless to other species. In fact it was all supposition, and it was planted without much thought or consideration. But like everything German it proved to be a Goth, a Hun and a Vandal to all our native species, though commercially it is somewhat of a success. When President of the Ohio Fish Commission, in 1890–92, I had all the brood carp seined from the ponds and sent to market, and replaced them with bull-head catfish, a good fish for the table, and one that will thrive wherever a carp will. It

should be more generally propagated and introduced to ponds in the south and middle west. I trust that what I have said in relation to the methods of Federal and State Fish Commissions will not be construed as criticisms, for we are all prone to mistakes as the sparks fly upward, from Moses to the present day. I have merely stated facts that have come under my own observation during an angling experience of seventy years, and an experience of fifty years as a fish culturist and naturalist.

A NEW FORM OF FISHWAY.

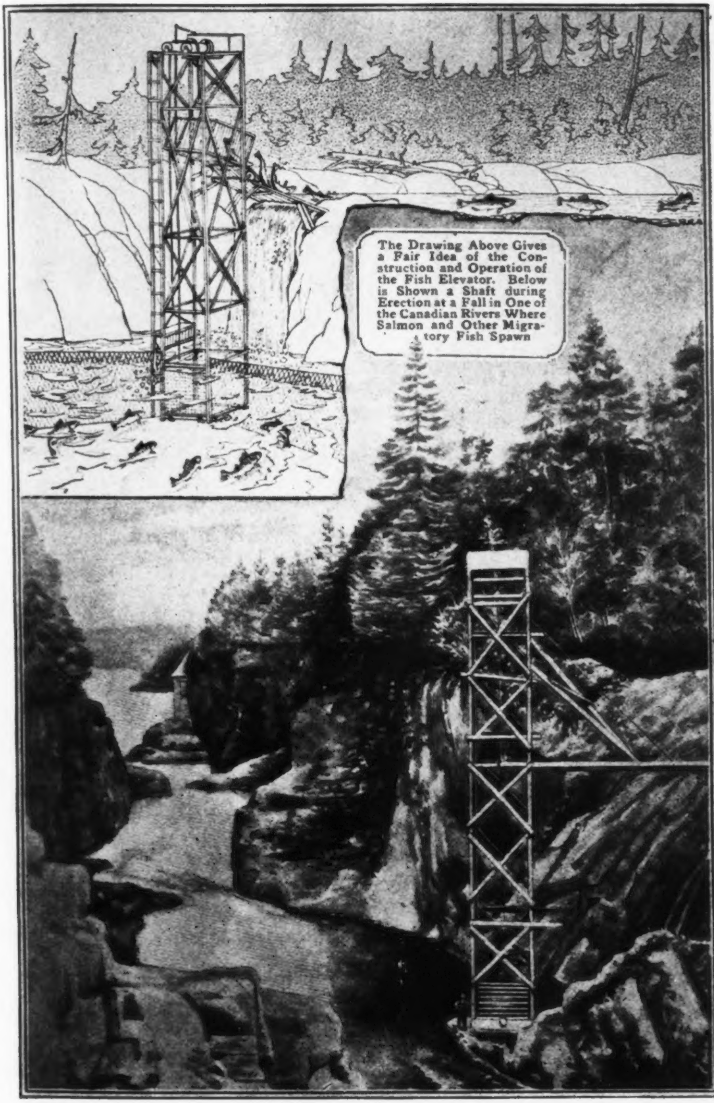
By Professor Edward E. Prince, LL. D., D. Sc.
Dominion Commissioner of Fisheries, Ottawa, Canada.

The principle upon which fishways or fish-passes have been constructed in the past has been by arranging the gradient so as to enable fish to ascend from a lower level to a higher level, and thus surmount water-falls, dams, and other obstructions. The greater the height of the obstruction, the steeper, or the longer, the gradient requires to be, and the head of water, or the force and amount of water, permitted to pass through the fishway requires to be varied to suit the different kinds of migratory fish passing up.

EXISTING FISH-WAYS UNSUITABLE FOR ALL FISH.

Each species of fish has its own climbing peculiarities, as it were, and the fish-pass which would suit one kind of fish may not suit another, shad and gaspereaux or alewives being altogether different from salmon or sturgeon. There have been fishways in Canada which proved successful for salmon, but the force of the water killed the weaker fish, such as alewives or smelts. The force of the water knocked these feebler fish against the compartments, and dead fish were often found, proving the utter unsuitability of the fishway for the different kinds of fish attempting to ascend it. Such fishways, as the McDonald fish-pass, endeavored to get over this difficulty of momentum, or force of water, by devices which broke the force and reduced the momentum, but as a rule the introduction of complicated arrangements for this purpose resulted in the accumulation of rubbish, and caused other difficulties, so that the structure was often rendered useless.

My new fishway, which has been tested experimentally in Canada with every evidence of success, adopts the principle of the perpendicular elevator, and if the fish can be induced to enter it, there is no doubt that it will lift them to the top of the obstruction.



THE FISH ELEVATOR IN ACTION

(This plate published by the courtesy of POPULAR MECHANICS MAGAZINE.)

THIS FISH-WAY IS SIMPLE, PORTABLE, AUTOMATIC.

The invention may be described as a fish-trap into which the fish swim and are enclosed, and then lifted up, and dumped over fish swim and are enclosed and then lifted up, and dumped over the top of the obstruction. It works automatically by means of a counterpoise or tank which is filled with water by gravitation or by means of a pump, and when full it descends, and in doing so pulls up the fish-trap below containing the fish. Any fish that can be induced to enter a fish-trap can be enclosed and lifted up by this apparatus. It consists of a comparatively light frame work of wood, iron, or other material so as to be portable, and it can be taken to pieces and stored away during the winter. One of the greatest dangers to the ordinary fish-passes is the accumulation of ice in winter about water-falls, dams, etc., which may amount to many tons, and which, during the freezing and thawing periods in winter and spring, often breaks up the fish-pass and carries parts, or it may be the whole of it away. Moreover, freshets in spring damage and destroy many of the fish-passes now in use. In the new fish-elevator the frame work, as I have said, can be taken to pieces, and the structure is not in use during the winter, when no fish are ascending. It is erected just prior to the first runs of fish in spring, and remains in operation only until the last runs of fish in the fall. As a fine-meshed wire net-work covers the whole frame work, rubbish cannot get into it and fill it up. Moreover, its success does not depend upon the varying supply of water, as the filling of the counterpoise can be arranged by taps and valves so that it will operate at regular intervals, whatever the state of the river. There is no necessity for erecting this fish-elevator at the point where the main body of water falls over; but it can be placed to one side, or indeed in any position where the fish can find their way into it, and being raised automatically and dumped out on a level with the height of the obstruction, a sluiceway of greater or lesser length can be devised to convey into the stream above the falls, the fish when dumped out. It can be placed anywhere where fish can be trapped, and there is no necessity for placing it directly against the face of the obstruction for if dumped into a sluice-way the fish can easily swim, as stated, to the pool or stream above the obstruction.

FISH LED IN AND ENTRAPPED.

The entrance to the fish-compartment or fish-trap is wide, and as the whole structure is a light frame work, there is no shadow or darkness about it, and the fish are not deterred on that account. It has been found that many kinds of fish object to entering a dark hole or chamber, but in this case there is no more difficulty in inducing the fish to enter the fish-compartment than in entering any automatic fish-trap along the sea-shore or along the banks of rivers. In order to compel the fish to enter the fish-trap, a wall of wire netting or "a lead" is suspended across the river diagonally which prevents the fish from ascending as far as the foot of the falls or dam and forces them to lead or be guided along the wall of net and enter the fish-trap, as in the case of ordinary commercial fish-traps.

HEIGHT, OPERATION INTERVALS, ETC., CAN BE VARIED.

The height of this structure can be varied for every different condition, and as it works automatically by gravitation, or if necessary, by electric or other power, it will operate as successfully for a low dam, 10 feet high, as for an obstruction, 30 or 40 feet in height; in other words, it is independent of the height of the obstruction. By the arrangement of special valves the counterpoise can be filled at the top of the elevator, and emptied at the bottom of the elevator, at any desired interval of time. In some cases it is desirable that the fish should be lifted up at intervals of not less than two or three hours, in other cases, where great schools of fish are ascending, it should ascend and carry the fish up every 15 or 30 minutes. This can be easily arranged by adjusting the valves.

OTHER FISH EXCLUDED WHEN TRAP ASCENDS.

When the fish-trap has ascended, the vacant space, which it occupied at the bottom, would be a danger to the fish trying to enter during the interval. To shut off the entrance of fish when the fish-compartment is ascending or descending, a special door has been devised which drops down and keeps the fish out, so that they are compelled to wait until the emptied compartment completes its descent. Then, by a special device,

the outer door lifts up, and the fish can enter. There are indeed three doors to this elevator. One is at the back, which opens only when the compartment is at the top of the structure, and the fish find exit by it. The second door is at the front of the compartment, and opens only when the compartment is at the bottom of the elevator, and thus admits the fish, and a third door at the bottom of the elevator which drops down only when the compartment has ascended, and thus prevents fish from entering the space left vacant when the compartment is going up or down.

OBJECTIONS ANSWERED.

The only objections which have been raised to this device are objections which are not really of very great force. Reference may be made to one or two of them. Thus, it is claimed, that the fish-elevator affords no means for the descent of adult fish after spawning, or of the young fish. Young fish can overcome all difficulties, however, in descending streams, and they can be trusted to look after themselves; the main purpose is to enable the parent fish to ascend to the spawning grounds. It has also been objected that the fish might be damaged when being lifted out of the water, and carried up in the fish-trap or wire-compartment; but inasmuch as salmon and other fish damage themselves considerably in jumping precipitous falls, there can be little harm to the fish during the few seconds occupied in being carried up to the top of the elevator. It has been objected, also, that logs and floating debris, and especially an excessive flow of water, might damage the fishway, but as a rule it would not be placed in position until the logs and high water have disappeared, and to avoid danger, it could be safely placed at one side of the obstruction. It need not be placed against the dam or falls, but at 50 or 100 yards away, and longer or shorter horizontal sluices constructed to carry the fish from the top of the elevator to the water above.

ADVANTAGES SUMMARISED.

To summarise the advantages possessed by this elevator fish-pass, which has been protected by patent in the United States, it may be claimed that it is (1) suitable for every kind of fish which ascends rivers. (2) It is not affected by freshets or by

accumulations of ice, as it is dismantled during winter and operates only when the fish run in the spring, summer, and fall. (3) It is automatic and operated by a counterpoise supplied from an elevated tank which fills by gravitation or by hydraulic ram. It may also be operated by electrical or other power. (4) It is adapted to all heights, 10 feet to 100 feet or more. (5) It is capable of being placed in any position in front, or at the side, or some distance below, the obstruction. A longer or shorter horizontal sluiceway enables the fish to pass from the top of the elevator to the pools of water above the dam or falls. No mill or power house is deprived of any water-power. (6) By adjusting the valves, the ascending and descending movements of the fish-trap or fish cage can be arranged at any interval, 15 or 30 minutes, or many hours; thus allowing ample time for a sufficient number of fish to enter the cage. (7) Should more enter the cage than the counterpoise can raise there will be no movement until some of the fish swim out, but the counterpoise is sufficiently heavy to raise the quantity of fish likely to enter during the short intervals allowed. (8) The cost of this device is much smaller than most other fishways in existence. It can be built for a few hundred dollars, being little more than a frame work, lightly but strongly made; whereas, some of the best fishways are costly structures of cement, masonry and timber, and cost many thousands of dollars.

TERRITORIAL WATERS AND A SUGGESTED EXTENSION OF THE THREE MILE LIMIT.

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On May 19, 1917, a German submarine seized the Norwegian steamer "Thorum" about four miles off the coast of Norway, and all who are interested in fisheries questions regarded this occurrence with special attention. It is generally thought that a three-mile limit is universally carried out, but in this case Norway protested that her territorial waters had been invaded, and international law violated, because she had always adhered to a limit of four miles. No doubt many people who regard themselves as well informed on the question of territorial rights on the sea coast, learned with surprise that Norway had, for over seventy years, enforced a limit greater than three miles, and in various national and municipal agreements had consistently carried this out. As long ago as June 18, 1745, Norway had enforced a four-mile limit.

MANY COUNTRIES CLAIM MORE THAN THREE MILES.

But Norway is not the only country that has enforced a more extended territorial limit of three miles, although her course is one of the few that has been recognized generally by other maritime nations. Spain, as long ago as December 17, 1774, also claimed six nautical miles along her coasts and the coasts of her colonies, and re-asserted this in several royal decrees, in 1775, 1785 and 1867. In 1869 it may be remembered that Spain re-asserted a claim to a six-mile limit around Cuba and her West Indian possessions. Spain's last decree, dated August 4, 1874, aroused, however, serious objections on the part of Great Britain and the United States. Italy has also enforced a limit of four or five miles; although in some special conventions with Austria, she adopted a three-mile limit, but it is doubtful how far this latter limit has been adopted. Indeed, when discussing this territorial question with the Western Powers in 1891, the Italian Government refused to recognize a three-mile limit, and certainly Genoa has never relinquished her claim to complete territorial rights extending over the waters

of the Ligurian Sea. It is interesting to note under the Treaty of Paris, 1763, it is specified that French fishermen shall have the liberty of fishing in the Gulf of St. Lawrence on condition that they do not come within a limit of nine geographical miles of the coast, nor nearer Cape Breton Island than 45 miles. The large claim of Great Britain to exclusive authority over the waters all around her shores, and extending in the North Sea to France and to Norway, was considerably interfered with by various Royal and Parliamentary Concessions. Indeed, up to 1851 the fishermen of Belgium had the right to fish within three miles of the British shores under a charter of Charles II, and the French fishermen also claimed privileges, which up to then, the Dutch fishermen had solely enjoyed. These concessions were of so uncertain a character that the British Government admitted until 1851 that the foreign fishermen referred to, might continue to fish within territorial limits if they proved to the satisfaction of the English Courts the validity of their claim. As M. Luis Maria Drago stated at The Hague Tribunal in 1910, in the coastal waters a century or two ago (when the doctrine of Selden's "Mare Clausum" was at its height), distances were fixed by various nations up to 60 miles, 100 miles, or a two days' journey from the shore, and the like. There was the utmost diversity and contradiction in the regulations which it was attempted to enforce in various seas. Indeed, the principle of "land kenning," i. e., claiming as much water as was covered by the distance land was visible from a ship at sea, had been adopted before the time of Grotius.

INTERNATIONAL THREE-MILE LIMIT INVALID.

It is an error, therefore, to claim, as has been very generally claimed, that a three-mile limit is an ancient accepted rule, universally recognized and admitted down to our own time. If it be asserted that such a limit is a canon of international law we are driven to ask, "What is international law?" about which so much has been said and written.

INTERNATIONAL LAW IS REALLY INTERNATIONAL MORALITY.

It is true that quite an extensive legal literature has grown up since the time of Grotius (1625), and other less known jurists, who gave definiteness to the general tendency of civilized nations

on this subject, chiefly in the famous "De jure belli et pacis." Yet even great jurists have felt that international law is a flimsy thing, and one of the greatest modern writers on the matter found himself compelled to speak of it as a branch of jurisprudence, which is the creation of moralists, merely moulded by the acumen of legal authorities and the wisdom of statesmen.

It was so well-known a writer as Professor Sheldon Amos who admitted that international law was very immature, ambiguous, and indefinite, and was lacking in legislative authority. The opinion of John Austin, an eminent authority on jurisprudence, is generally admitted to be sound, and he does not hesitate to say that "international laws are improperly so termed," the laws being framed and emphasised merely by the opinion of an indeterminate body of men. As the three-mile limit derives its authority from such indefinite moral and ethical principles and summaries of international sentiment and obligation, its foundation is vague and unstable. John Austin very properly designates it "positive international morality." Law, to have any force or meaning as Sir Henry Maine stated, implies not only an authority to pronounce it law and to define it, but a tribunal capable of enforcing it. There exists no international tribunal sufficiently powerful to bind sovereign States by its decrees, and use compulsion if they transgress those decrees.

During the great war some interesting questions arose as to the cargoes held in seized German steamers at the Antipodes, and the New Zealand Chamber of Commerce, in the capital city of Wellington, when discussing the question of charging certain costs against the seized ships found the objection raised that such could not be done under international law, because at the end of the war these seized steamers must be handed back to the German owners. The President, Mr. C. W. Jones, a prominent New Zealand merchant, thereupon declared to his colleagues that "there has been no such thing as international law since the great war began." International law, it was claimed, can be violated with impunity and amounts to little more than international etiquette or morality.

Important maritime powers in former days assumed authority over vast oceans and seas, and had even Papal sanction for these extensive territorial claims. The known oceans of the world were

largely divided amongst the leading states as their national property. Britain, when she became a great maritime power, and rival of Spain and the Netherlands, asserted very wide claims over the seas. The House of Commons, in 1660, declared that foreign vessels were prohibited from fishing within eight or ten miles of British coasts; but the prohibition was generally ignored. During the eighteenth century the principle of "armorum vis" became pre-eminent, owing to the great naval wars, and waters within cannon-shot of the shore became regarded as territorial. Bynkershoek's principle "terrae dominum finitur ubi finitur armorum vis" appealed to warring nations, so that a 3-mile limit became regarded as equivalent to armed power, or force of arms, i. e., equivalent to the range of guns, and the exclusive right of fishery within such limit became an implication; but it is doubtful if three miles ever was the real limit of artillery range and certainly the limit is obsolete in modern warfare; even for civil and national protective and other purposes. A three-mile limit has always been regarded as quite insufficient. When Venice was an independent power, she exercised absolute dominion over the whole of the Adriatic sea. Every ship entering that sea had to acknowledge her authority, consent to be examined, and pay the tribute enforced. The Pope, who possessed Ferrara, about 50 miles south of Venice, was annoyed that his ships were overhauled and their cargoes taxed by Venice, and he called the Venetian Ambassador to Rome to explain the position. That officer explained that Venice had absolute and perpetual dominion over the Adriatic sea by enactment of the "Donation of Constantine." The Adriatic Sea is about 500 miles long, and averages more than 100 miles in width. Although the excessive and obsolete claims over the "common ocean," to use M. Drago's words, have been largely relinquished, the assertion of exclusive property over large tracts of water, has not been abandoned by many of them. It is an interesting fact that the very first definition of the three-mile limit of coastal jurisdiction was contained in the Treaty of 1818, between the United States and Britain, but neither of the powers signing that Treaty has rigidly carried out a three-mile limit even on its own shores. The United States has always exercised the rights of exclusive property over Chesapeake Bay, Delaware Bay, and other areas, and Britain quite recently insisted upon her

rights in the Moray Firth, beyond the distance of three miles from shore.

THREE PREVALENT ERRORS REGARDING THREE-MILE LIMIT.

Prevailing ideas upon the question of territorial waters seem to me to urgently require revision, hence I venture to bring the subject before the American Fisheries Society for consideration. The members of this Society are interested in everything pertaining to the conservation of the fisheries, and if it can be shown that the so-called three-mile limit is insufficient and unsatisfactory from a fisheries' point of view, I venture to hope the Society may place itself on record as favoring a satisfactory readjustment of the matter, and that the leading maritime nations may adopt a limit better fitted to conserve the just rights and interests of all concerned.

Space will not permit reference to the "headlands question" and other points, and I shall keep the fisheries mainly in view.

There are three common errors in the minds of many so-called experts regarding the three-mile limit.

(1) It is regarded as very ancient and venerable, and as established by antiquity and usage and by the general consent of nations. (2) It is regarded as universally applied and adopted. (3) It is asserted to be a canon of international law.

None of these assertions are true.

Let me take the last first. If it be claimed that international law has laid down the principle that no territorial sovereignity exists, or can be claimed, beyond the three mile zone, we must ask, I repeat, "What is international law?" It is true that there are Conventions and Treaties and understandings between nations. These are the only definite materials which can be regarded as having any force or binding power. Apart from these, international law is a compound of vague affirmations and claims with little possibility of enforcement, and liable at any moment to be violated or to be ignored with impunity. A great modern authority said that international law is "jus inter gentes"—consisting of natural and conventional elements, and so far as it is a law of nature, it is of uncertain obligation, while even the positive elements in the shape of treaties, agreements, precedents, etc.,

are only obligatory in so far as the nations concerned regard them as having moral force. International law is indeed derived originally from general and abstract theory, and it is difficult to see how it can have the same force and obligation as the criminal and civil laws of nations.

Germany, when she ignored her solemn treaties and violated the requirements of international morality, showed how futile are the claims made on behalf of international law. It fails when most needed. It is merely a collection of requirements in which the opinions of an indeterminate body of men are crystallized, and these opinions may or may not govern the conduct of those independent political societies which we call nations. If the three-mile limit is an essential part of international law, it has neither weight nor imperative obligation to support it. A country like New Zealand, with no foreign neighbors near at hand, and not bound by treaties or formal agreements with sister countries, is free to establish any territorial limit which she is prepared to enforce. Indeed, in some recommendations which I made to the New Zealand Government five years ago, I recommended that owing to her isolated situation she could be justifiably the first to announce a 10-mile or 12-mile territorial limit for the benefit of her sea fisheries. The principle applies, of course, to all countries, except in so far as they are bound by treaties with particular nations, or groups of nations.

It is a mistake to claim that the three-mile limit is universally recognized or adopted. The main ground for this opinion is based on the fact that some of the most important nations in the world in their treaties and conventions with one another have, at times, specified three miles as a territorial coastal area. Such nations as the United States, Great Britain, and France, and some of the nations bordering on the North Sea, have done so, but because, in certain instances, two or more nations have bound themselves by such limitations, there is no reason why any country that desires to do so, and is free to do so, may not claim more than three miles as its territorial boundary waters. The examples already given of maritime people like the Norwegians, or the Swedes, who have asserted their authority over more than three miles suffice. That Norway has not hesitated in her claim, is proved by the fact that she recently promulgated a new law

specially prohibiting foreign trawlers from approaching within four miles of her coast. The violation of this law renders the offenders liable to a penalty of from one thousand to five thousand kroners, and the confiscation of the offending vessels. The British Government directly called the attention of trawlers from British ports to the existence of this law, and in the official notice from the Board of Trade, London, dated November, 1908, and signed by the Assistant Secretary, Mr. Walter J. Howell, and headed, "Notice to owners and skippers of trawlers in territorial waters," it is stated that "The Board of Trade desires to call attention to the fact that a new law has recently come into force in Norway under which fishing with a trawl is forbidden in Norwegian territorial waters. * * Territorial waters of Norway are four English miles, not three miles."

Attempts have been made at various times to induce Norway and Sweden to reduce this coastal limit, and when these two nations separated from each other the British foreign office urged Norway to join in the North Sea Convention of 1882, but she rejected the proposal, because it would have bound her to a three-mile limit. It is interesting to note that Denmark enforces a three-mile limit in her western waters, but a four-mile limit in the Baltic Sea.

It is by no means true, moreover, that the three-mile limit has the authority of antiquity or the universal consent of leading nations, and some of the most famous jurists, such as Martens, admitted that any nation might acquire marine dominion beyond a three mile limit; indeed he asserted that three leagues, not three miles, was really the limit. Nor is the idea correct that gun-range in old times was three miles, and that the limit was based on that. Indeed, the earliest authority to announce the theory was the Sicilian Secretary of the Italian legation at Paris, Galiani, who first stated that a distance of three miles was equivalent to the range of guns, yet that two leagues, or twice that distance, should be the area for observing neutrality, or in other words should be the limit for enforcing territorial rights. Moreover there was uncertainty as to the base from which the three miles might be measured. Norway and Denmark and some other countries adopted a straight line drawn from point to point along their coast, and measured the three miles from that. An ancient

authority establishes a much greater distance than three miles, and the limits were fixed at 60 miles, or 100 miles, or two days' journey from the shore, and so on, and it was not until the Treaty of 1818 that three marine miles assumed definiteness as a limit of coastal jurisdiction.

M. Luis M. Drago, in his important addendum to the Award of The Hague Tribunal on the North Atlantic Fisheries (Septemper 7th, 1910), says "The Treaty of 1818 is one of the few which mark an era in the diplomacy of the world. As a matter of fact it is the very first which commuted the rule of the cannon-shot into the three marine miles of coastal jurisdiction," and Kluber specially referred to the Treaties of October 20th, 1818, and August 2nd, 1839, as fixing a distance of three miles from low-water mark for coastal jurisdiction, but it must be added it fixes the limit only for the nations who are party to such conventions.

The unratified Treaty of 1888, between Great Britain and the United States, specified three marine miles seaward from low water mark. It is to be noted, however, that unless the nature of the mile is defined, great uncertainty arises when three miles are mentioned in a Convention or Treaty, because the length of a mile varies in different countries and has undergone great changes at different periods of time. Before the reign of Elizabeth, an English mile was 5,000 feet, but in the thirty-fifth year of her reign, it was defined as eight furlongs, or 1,760 yards of 3 feet each. The English nautical or marine mile is 2,025 yards; but the German geographical mile is equivalent to four nautical miles, i. e., one-fifteenth of a degree. The German short mile is 6,859 yards, the French mile 4,263 yards, the Dutch mile 8,240 yards, and the Spanish mile is 4,635 yards.

There is no uniformity in the terms used to define territorial limits, in various treaties. Thus in the North Sea Convention of 1882, between Great Britain, Denmark, France, Germany, Belgium and Holland, three geographical miles are specified, whereas a marine league, or three marine miles is the distance mentioned in the Treaty (unratified) of 1888, between the United States and Britain. Three marine miles are specified in an early Fisheries Act in Canada, viz., the New Brunswick Act, passed on April 30th, 1851, by the Legislative Council and Assembly of New Brunswick (Act 14, Victoria, Cap 31).

NO THREE-MILE LIMIT ON INTERNATIONAL BOUNDARY WATERS, GREAT LAKES, ETC.

The Great Lakes, though from a legal point of view regarded as "high seas," and so defined by the Supreme Court of the United States, are really wholly territorial, being Canadian on one side of the boundary line and American on the other, a breadth ranging from 5 to 200 miles. The fishermen of one country are prohibited from operating in the waters on the further side of this imaginary line and the fishermen of nations other than the two bordering on the lakes are absolutely excluded altogether. They are in every sense extensive territorial waters separating two great countries.

In the Gulf of Georgia and Juan de Fuca Straits, Canada and the United States, by the Award of October 21, 1872, each acquired territorial waters on either side of the boundary line ("the line of demarcation between the territories," the Treaty of 1846 expresses it), from one to twenty miles from shore, while by the Award of October 20, 1903, the United States acquired territorial waters on the Alaskan boundary extending from four or five to thirty miles north of the line* extending from Cape Muzon to Cape Chacon; and Canada on the south side of that line acquired territorial waters of forty miles in breadth.

LARGE TERRITORIAL LIMITS FOR SPECIAL FISHERIES.

There are numerous instances where a special industry has required limits far in excess of those generally recognized for ordinary fishing operations, and large limits have been adopted without hesitation. The Russians, for example, reserved for a long time the White Sea for sealing, and in 1911 established a 12-mile limit in that sea or rather in Barents Sea; and Great Britain and Norway, assented to that claim. The line is drawn from Cape Svtoai to Cape Kanin. Norway, in like manner, closed Vanagar Fjord, in order to preserve the supply of whales. Great Britain, Sweden, Norway, Russia, Germany and Holland passed concurrent legislation to preserve the Jan Mayen Sealing Industry east

* The Treaty defines the line as "the line of boundary between the territories."

of Greenland. The Behring Sea Tribunal in 1893, established a 60-mile zone for fur-seals. A similar zone of 10 miles in the north part of Behring Sea, and a 30-mile zone around Robbins Islands were determined by an agreement between the United States, Russia and Great Britain. Delaware Bay, which is 20 miles wide at the entrance and 30 miles across inside, and 70 miles long, is recognized as within the territorial jurisdiction of the United States, while Chesapeake Bay, which is 12 miles wide at the entrance expands into a large arm of the sea, 270 miles long, and it is entirely closed to all foreign fishermen. Thus, when the fishery interests of a nation require it, the so-called three-mile limit has been repeatedly set aside.

There has been a strong feeling in Canada that the waters inside Queen Charlotte Islands, on the Pacific coast, are really territorial, and so long ago as 1896 Canadian patrol vessels warned foreign fishermen against operating in those waters.Captain Walbran of the D. G. S. "Quadra" reported to the Department when this warning had been issued that his coming had been made known to many United States' vessels that had been fishing there, and he found only one operating, which left at once for Alaskan waters after being reminded of the warning, and, said the Captain, "not another vessel appeared in those waters for five weeks," during which he continued his patrol. The fishermen, in other words, recognized that they were fishing in Canadian waters, and the area is certainly almost entirely enclosed on three sides by Dominion territory. The waters at one point are 75 miles wide, but the mere width is not conclusive, as the entrance to Long Island Sound is 10 miles, and to Delaware Bay is nearly 30 miles wide. By the Alaska Treaty the northern end of Hecate Straits, or rather Dixon Entrance is territorial, and in Juan de Fuca Straits, in the south, the waters north of the boundary line are also territorial, and it is difficult to see how any waters between these two boundary lines can be claimed to be "high seas."

VALIDITY OF LARGER LIMITS THAN THREE MILES.

It may be said that the larger limits which have been referred to are special cases, which are exceptions to the general rule. This is not so. Quite recently on the Scottish coast a Norwegian steam fishing vessel, the "Niobe," was seized when trawling

in the Moray Firth.* Captain Mortensen, in command of her, was found guilty of operating in waters five miles from the shore, on the ground that the Firth had been set aside by the Scottish Fishery Board under the authority of the British Parliament as an area in which trawling was forbidden. The offender, when found guilty, protested that five miles from land was "high seas," but the Appeal Court, in London, dismissed this protest on the ground that the British Parliament had assumed jurisdiction over the waters in question, and it was not for a Law Court to decide whether it had gone beyond its authority, merely because a three-mile limit had been defined in the North Sea Convention in 1882, and Norway was a party to it. Doctor Bassett Moore, one of the most eminent and scholarly authorities on International Law, said that this final decision was in accordance with United States' policy, for the Courts follow the decision of those Departments of the Government to which the assertion of its interests is confined, i. e., legislative and executive.

It is an error, therefore, to claim, as has been very generally claimed, that a three-mile limit is universally recognized and admitted. A slight examination of the facts shows that it is by no means universally recognized. Uruguay, ten or twelve years ago, claimed jurisdiction five miles from shore, and only receded from her position when Great Britain strongly protested; but she still exercises domination over one-half of the river La Plata. The other half belongs to the Argentine Republic. The river is 135 miles wide at the mouth of the estuary, and as much as 50 miles wide over 100 miles from the open sea.

In 1876 the Chief Justice of England decided that a German captain had been illegally convicted of having caused the death of a number of British subjects in a collision with his steamer, the "Franconia," inside the three-mile limit. He stated that the conviction was based on International Law, not on a British Parliamentary Statute. It is very remarkable that no three-mile limit had been authorized by statute in Britain until forty years ago (1878) and in that year Parliament in London passed an Act

* The Moray Firth, 148 square miles in area, had been closed by the Scottish Fishery Board, but foreign trawlers persisted in fishing there, maintaining that the prohibition did not affect them, as a large portion of the Firth is outside territorial limits.

to remove the uncertainty. By this action of the British House of Commons, jurisdiction was declared to extend, according to International Law, to three miles from the coast line. The United States had taken like definite action long before. Indeed, it was no other than George Washington who enforced authority over waters extending to one marine league, or three geographical miles, from the coast of the United States, and he added that this did not fix the distance to which the United States might ultimately extend its authority.

In conclusion, it is only necessary to point out (1) the three-mile limit has not been universally adopted or recognized.* (2) Ancient writers and modern writers who have been regarded as authorities have specified more extended limits. (3) Britain and the United States, though they have both specified three miles as the limit in various Conventions and Treaties, have themselves claimed more, when occasion required, and have legally justified their claim. In Britain, until recently the three-mile limit had practically no legal force because it had no statutory authorization. (4) Important legal institutions and Congresses have favored a greater limit than three miles. It is necessary only to refer to the International Law Association which took action at its annual meeting in 1895, the International Fisheries Conference, Bergen, 1898, the French International Law Institution, and other important bodies, all of which have urged that a greater limit than three miles should be adopted, and in many cases a ten-mile limit was specified. (5) For the object of fishery conservation a larger limit is very necessary. The spawning grounds for fish, and nurseries for the young, require to be protected, and in a vast number of instances these are beyond the three-mile limits; while important industries such as the whale, mackerel, halibut, and other fisheries, have been threatened with total extinction, and require closed areas or sanctuaries against the intrusion of outsiders, so that when special reserves are established they can be effectively protected by the nation having jurisdiction, and a three-mile limit is usually not enough.

* M. Luis M. Drago (op. cit. p. 37) candidly admits that "there does not seem to be any general rule of international law, which may be considered final, even in what refers to the marginal belt of international waters."

The great salmon fisheries both on the Atlantic and Pacific coasts require a larger limit than three miles, if they are to be safeguarded in the future. We know that on the Pacific coast the King or Quinnat salmon do not wander far from the rivers in which they spawn, probably twenty-five miles distance is the limit, but the great schools of sockeye salmon no doubt go further out, and descend into deep water to their feeding grounds. To protect these fish when approaching the estuaries of the most famous salmon rivers, a larger limit than three miles is essential.

There has always been the danger that Oriental nations might find it worth their while to send their fishermen across to the Pacific shores of the United States and Canada, and by the use of purse-seines, and other destructive implements, within five or ten miles of shore, destroy great masses of fish before they reach the estuaries or inshore waters, just as the French, Portuguese, and other European nations found it worth while to cross the Atlantic and exploit the cod and other fishing banks on our eastern Atlantic shores. The danger on the western coast is not imaginary, for fishing vessels from Asia have already visited American inshore grounds close to territorial limits. One such vessel, the Japanese halibut schooner, "Sunburst," was wrecked in the summer of 1908, while fishing close to Victoria, B. C.

It is claimed that larger territorial limits would ward off many of the dangers, to which reference has been made, and would ensure that salmon and other fish within ten or twelve miles from the coast would be free from the risk of reckless destruction by foreign fishermen. In the interest of the fisheries of most countries, a wider territorial jurisdiction is urgent, and would ultimately be beneficial even to other nations more distant who would gain by the plentitude of fish that would ensue.

In recent years there have been numerous respesentations in favor of a larger territorial area, and in 1893 one of the most prominent Parliamentary advocates of British fisheries protection and preservation, the late Lord Tweedmouth, strongly advocated a limit of six miles as desirable for adoption by maritime nations generally. He had been chairman of various fishery commissions in Britain, and was looked upon as the mouthpiece of fishing interests in the British House of Commons, and his emphatic opinion after long years of experience was, that the present limits

of three miles were altogether inadequate. Following the lead of this eminent man, that important and powerful association in Britain called "The National Sea Fisheries Protective Association," meeting in Fishmongers Hall, London, on January 16th, 1894, passed a resolution which included the following:

"That in view of the difficulties of making international fishery regulations, they are of opinion that the best method for effectively governing fishing operations, and, at the same time, for securing, so far as it may be found possible, the proper protection of spawning and immature fish, would be to throw the responsibility of these duties, so far as the waters immediately adjacent to the various countries are concerned, on those various countries; that, for the effective realization of this object, the present territorial limit of three miles is insufficient, and that for fishery purposes alone this limit should be extended—provided such extension can be effected upon an international basis and with due regard to the rights and interests of all nations." It may also be noted that Inspector W. E. Archer, one of the leading fishery authorities in Britain, laid great stress in some evidence he gave before the Sea Fisheries Commission in 1907, that the three-mile limit for fishery purposes was practically insignificant.

Of special moment is the fact that at the commencement of the great war, in 1914, twenty-one American Republics, including Argentina, Chile, Brazil, Peru, Uruguay, etc., were moved to urge co-operation with the United States Government to extend the territorial marine limits, mainly to increase coast-wise trade between North and South America, but indirectly for the benefit of the sea-fishing industries also. Quite a large and representative body of men from these various republics arranged to confer with President Wilson upon this momentous subject.

It has been widely felt that six miles was not a large enough limit, and the fishermen of Scotland twenty-five years ago urged upon the British Government that the territorial limits should be extended and the line fishermen, who formed the majority, specified a thirteen-mile limit as necessary, and demanded that within this limit no trawling should be permitted. The Government officials in London replied that the consent of foreign nations concerned would be required; but as we have seen this opinion was entirely baseless, as proved by the decision of the High Court

of Appeal of England in the "Mortensen case." The well known Canadian Herring Commission, 1889, which published a splendid report upon all phases of the industry, refer on p. 79, to the prohibition of trawling in the three-mile limit, and they say: "We consider trawling, especially within the territorial limits, to be exceedingly injurious to the herring fishery. It is established on undoubted authority in Britain and Ireland that trawling scares away the herring from the fishing grounds, drives them away from the spawning grounds, and disturbs and destroys the spawn when deposited. The salmon, halibut, lobster, and flatfish fisheries generally, have been seriously injured, and in many cases destroyed, by the operations of the trawlers. We, therefore, consider that trawling and the use of all destructive seines and traps, calculated to disturb the herring in any way and to destroy large quantities of immature fish and spawn should be prohibited within the three-mile limit, and that efforts should be made by the Government to effect an international arrangement whereby the trawling on the high seas should be regulated and restrained when the herring schools are in close to the coasts so as not to drive them away from the fishing or spawning grounds, or disturb or destroy the spawn when deposited on banks outside the territorial waters." From a strictly scientific point of view the grounds stated by this Commission, for the action suggested, are not altogether well-founded, but it must be admitted that there is great force in the view that excessive fishing operations within short distances of the shore must injure all fisheries.

The extension of the territorial limits would enable better supervision to be carried out, at greater distances from shore, and in 1915, the Canadian Government authorized by Order in Council a prohibition of trawling operations within a distance as great as twelve miles. Owing to war conditions, enforcement was postponed. There is no reason, however, why such a special method of fishing as trawling only should be curtailed or controlled within that distance, but that all methods of fishing should be under wise regulation within a distance much greater than the present territorial limits off the shores referred to.

Lastly, in order that some practical results may be possible, I have, as urged by some leading members of the American Fish-

eries Society, framed the following resolution,* which I would submit to the Society and ask for their valuable support. This draft resolution reads as follows:

PROPOSED RESOLUTION.

"The American Fisheries Society places itself on record as being in full agreement with L'Institut de Droit International, Paris, 1894; the International Law Association, London, 1895; The International Fisheries Conference, Bergen, 1898; and other important representative bodies, which have urged the extension of the territorial limit in coastal waters, and have emphasized the fact that the three-mile limit popularly regarded as internationally valid is entirely inadequate, and that in the interest of fishery conservation and protection, and in furtherance of international amity, approves of a suggested larger territorial limit extending beyond the usually accepted three-mile limit on the coasts of the various maritime countries of the world."

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* By vote of the Society, Dr. Prince was requested to frame this resolution to be printed in connection with his paper, in order that it may have proper consideration before the 1919 meeting. Members of the Society will please take notice that this resolution will come up for action at the comming meeting at Louisville, Ky., Oct. 8 to 10, 1919.—EDITOR.